

Gearing up for Transportation Engineering, A Summer Institute Phase II

By

Kathleen M. Leonard, Ph.D., Michael Anderson, Ph.D.,
John A. Gilbert, Ph.D., and Houssam Toutanji, Ph.D.,
Civil & Environmental Engineering Department
University of Alabama in Huntsville
Huntsville, Alabama 35899

and

Norbert Delatte, Ph.D.
Civil & Environmental Engineering Department
University of Alabama in Birmingham
Birmingham, Alabama

Prepared by

UTCA

University Transportation Center for Alabama

The University of Alabama, The University of Alabama in Birmingham, and
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16. Abstract The numbers of female and minority students enrolled in engineering schools are increasing slowly; however, a relatively small percentage of these students are drawn to the field of transportation engineering. For this reason, there is a need to educate young people about the profession and to encourage under-represented individuals to appreciate the contributions of engineers and to become civil engineers. This Summer Institute project consisted of two groups of twenty middle school students who were invited to the University of Alabama in Huntsville campus to learn about engineering as a career and to experience a variety of transportation engineering design topics. The participants gained knowledge about the role of engineers in society, and learned how engineers use their knowledge in design applications. Five University of Alabama System engineering faculty members, as well as professionals representing Society of Women Engineers (SWE) and National Society of Black Engineers, served as instructors for the hands-on laboratory sessions. As an important part of this project, minority and female engineering students served as mentors for the program.			
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Executive Summary

The numbers of female and minority students enrolled in engineering schools are increasing slowly; however, a relatively small percentage of these students are drawn to the field of transportation engineering. For this reason, there is a need to educate young people about the profession and to encourage under-represented individuals to appreciate the contributions of engineers and to become civil engineers.

This Summer Institute project consisted of two groups of twenty middle school students who were invited to the University of Alabama in Huntsville campus to learn about engineering as a career and to experience a variety of transportation engineering design topics. The participants gained knowledge about the role of engineers in society, and learned how engineers use their knowledge in design applications. Five University of Alabama System engineering faculty members, as well as professionals representing the Society of Women Engineers and the National Society of Black Engineers, served as instructors for the hands-on laboratory sessions. As an important part of this project, minority and female engineering students served as mentors for the program.

Section 1

Introduction

Problem Statement

Objectives

The numbers of female and minority students has been increasing overall in engineering and science (National Commission on Excellence in Education, 1983); however, a relatively small percentage of these students are drawn to the field of civil and transportation engineering. For this reason, there is a need to educate young people about the profession and to encourage under-represented individuals to become engineers and contribute to transportation technology.

Approach

The major goal of this program was to introduce middle school students from under-represented groups to basic engineering and transportation-related concepts. The project drafted local minority and female engineers to serve as team instructors and mentors. Participants used real world examples and new technologies in their hands-on activities to reinforce the concepts presented by the engineering mentors. A final comprehensive team project was used to tie the knowledge together in a design competition.

Section 2 Background

Huntsville and Madison County Schools

In past years, the University of Alabama in Huntsville (UAH) and the American Society of Civil Engineers (ASCE) worked with local schools in the Huntsville, Madison County and Morgan County and became aware that local public schools do not have any formal relationship with the engineering academic and technical community. In addition, these school systems have a high ratio of minority students, approximately 25% of total enrollment. For this reason, local county middle and “science magnet” school principals and teachers were asked to nominate students for this Summer Institute. Under-represented students, females and minorities, were especially targeted. This year, a week was dedicated to the North Alabama Girl Scouts to encourage females to attend the program. A committee consisting of representatives from each of the participating groups selected twenty participants based on potential rather than classroom grades.

This Summer Institute project consisted of bringing selected middle school students to the UAH campus to learn about various aspects of engineering and to experience transportation-related design and safety topics. This opportunity may encourage them to consider civil and transportation engineering as a career option and increase diversity of the workforce, a problem in some areas of the country (U.S. DOT, 2000).

Section 3

Methodology

Science Teaching Method

Recent efforts to reform science education in schools led to the development of the Science/Technology/Society (STS) teaching method. Some important aspects of the STS method are that students must feel a concept is personally useful for solving specific problems, and that students who learn through an experience will retain information and will be better able to apply the information later to new situations. STS instructional and interactive experiences were developed in this project to generate interest in transportation engineering and related science topics. The program was initiated in the first Gearing Up for Transportation Engineering Program (GUTEP) Summer Institute in 2000. The 2001 program refined the laboratory activities and put the manual on the UAH UTCA web site. Once the individual projects and full curriculum are developed and tested, the program can also be implemented for on-site school visits.

The strategy of this program was aimed at producing students who know “how to find out” and “how to examine and evaluate evidence.” As discussed in last year’s UTCA final report {Leonard et al, 2000}, the following criteria were used in designing the hands-on experiments:

- The activities were designed to be completed by the students; not as demonstrations performed for the class by the instructors;
- The students must be able to read, perform and document the experiments themselves with limited adult supervision;
- Each experiment was designed so that the results were sufficiently dramatic to maintain the student's attention with a high probability of success;
- Experience has shown that middle school students work best in teams, so the activities and equipment were appropriately structured;
- In general, each experiment took approximately 1-1.5 hour including set-up and clean-up, and follow-up discussions were held to highlight concepts and results; and
- Safety and good lab protocol were practiced and stressed throughout.

To accomplish these goals, students were encouraged to use the following design heuristic in their team transportation problem:

1. Define the problem;
2. Generate possible solutions, using brainstorming and other creative thinking techniques;
3. Decide on a course of action;
4. Integrate the solution; and
5. Evaluate the solution.

The following list of national science education standards' topics (National Research Council, 1998) and skills was used as a template for GUTEP activities. Attention to appropriate skill level was a major factor in the preparation of these activities.

Physical Science

- Motions and forces
- Transfer of energy

History and Nature of Science

- Science as human endeavor
- Nature of science
- History of science

Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry
- Develop descriptions, explanations, predictions, and models using evidence

Science and Technology

- Abilities of technological design
- Design a solution or product
- Implement a proposed design
- Evaluate completed technological designs
- Abilities of technological design
- Understanding about science and technology or products

Science in Personal and Social Perspectives

- Science and technology in society
- Populations, resources, and environments

Unifying Concepts and Processes

- Evidence, models, and explanation
- Form and function

Science Process Skills

- Collecting data
- Constructing
- Inferring
- Measuring
- Communicating
- Making models

- Interpreting data
- Controlling variables
- Investigating

This project met UTCA goals of increasing diversity in the transportation field, and thus affects Alabama's future human resource population by using technology transfer through focused educational activities.

Section 4

Project Results

Tasks Completed

This project had a one-year duration commencing in January 2001. The following tasks were completed to achieve the desired goal of transportation education through technology transfer.

Recruiting – Project members sent letters to schools, made phone calls to science teachers and made follow-up contacts. The North Alabama Girl Scout office program facilitator (Ms. Willow Caldeira) was instrumental in contacting all junior/cadette troops about the GUTEP program. The program committee selected 40 students based on their potential and interest levels.

Schedule Mentors – We contacted professional organizations (National Society of Black Engineers, Society of Women Engineers, American Society of Civil Engineers), college chapters of the societies, local companies (Boeing and Sverdrup), and the Huntsville Center of the US Army Corps of Engineers.

Set-up schedule and lab experience –

- a) The principal investigator met several times with instructors to discuss objectives of each lab experience;
- b) Professors were asked to update individual experiments as indicated by last year's survey results;
- c) Trial runs were made on labs with several cadette girl scouts during Engineer's Week;
- d) Laboratory instructions were obtained from the co-PIs;
- e) Supplies were obtained; and
- f) Campus rooms and field trips locations were scheduled.

Summer Institute – Week 1: June 4-8, 2001; Week 2: June 11-15, 2001

- a) Students were divided into five teams of four students each, for concurrent lab sessions;
- b) The schedule was followed (see Appendix A); and
- c) On the last day of each week – participants gave demonstrations and design reports on future transportation modes to judges.

Deliverables

A manual was assembled for implementation during school visits. All five investigators were responsible for completing their laboratory experiments. The team members completed the evaluation of the final manual for teachers and students. The manual was posted on the UAH UTCA web site in html format. The final report was completed and sent to UTCA in December 2001.

Synopsis of Student Hands-On Experiments

GUETP ran for two one-week sessions on the UAH campus. The mornings were scheduled for informative sessions, followed by lunch. The afternoon activities were characterized by more "hands on" experiences, such as design projects and laboratories. The last day concentrated on team building and a "vehicle of the future" design project. A summary of each laboratory experience follows, and the two new experiments are included in Appendix B. Photos from the Summer Institute are included in Appendix C.

1. Strength of Materials (new this year)

Objective: Students will understand how forces and moments create stresses and strains in materials and structures.

Description: Students will perform simple experiments in the UAH Mechanics of Materials Laboratory to demonstrate how forces and moments are created and balanced to achieve equilibrium.

2. Space Transportation

Objective: This lab demonstrates how rocket liftoff is an application of Newton's Laws of Motion. Students also will learn about the history and future of space transportation in the USA (NASA, 2000).

Description: Demonstrate how rocket liftoff is an application of Newton's Laws of Motion. Students construct a rocket powered by the pressure generated from an effervescent antacid tablet reacting with water. Students also use the NASA disk "Space Transportation: Past, Present and Future" to learn about space applications.

3. Construction Materials

Objective: Learn about different types of materials used for roads, bridges, parking lots, dams, and buildings.

Description: In this activity, students learn about engineering materials used in transportation, such as wood, metals, concrete, pavements, and composite materials. They will prepare and test some of these materials.

4. Surveying

Objective: Learn about different ways to measure distance and make a simple map.

Description: In this activity, students will learn how to use simple ratios to estimate distances. The use of a level and tape will be used to estimate slope. They will also learn how use their stride and a compass to make a simple map.

5. Alternative Energy

Objective: Explore alternative energy sources, other than fossil fuels, for future transportation modes; to stress the importance and effectiveness of alternative energy sources.

Description: In this activity, students perform experiments using a solar cell and test a small solar powered car. They will observe the physical power of light/heat absorption through a small free moving device with black and white panels. Each student will construct a solar powered car.

6. Bridges

Objective: Learn about different types of bridges by building simple models.

Description: In this activity, students construct a simple span bridge. They will use an interactive computer simulation model to design a suspension bridge to carry the load of a truck. They will also build a scale model of their bridge design.

7. Transportation Simulation (new for this year)

Objective: Learn traffic engineering concepts, level-of-service, and how traffic engineers use micro-simulation to analyze roadway intersections and design city streets.

Description: In this activity, students explore traffic micro-simulation and determine existing and future levels of service for different roadways systems. The students will learn about highway design principles related to intersections and traffic signal control.

8. Transportation Safety (updated for this year)

Objective: Explore issues related to automobile safety; learn ways to design safety into cars.

Description: In this activity, students learn about bike, bus and auto restraints safety. They also perform experiments illustrating safety features using eggs.

9. Future Transportation Design Problem

Objective: Design and build a working model of the team's vision of a future transportation vehicle.

Description: In this activity, students design a prototype of a vehicle of the future. They construct a working model with motorized K'nex kit. It must meet energy, safety, and infrastructure constraints.

Field Trips

Past Modes of Transportation – The North Alabama Railroad Museum, Big Spring Canal
Current Modes of Transportation – The Huntsville Jet port and Inter-modal facility
Transportation Engineering – The City of Huntsville Engineering and Sign Shop
Future Modes of Transportation – The National Aeronautics and Space Administration's
Marshall Space Flight Center's space station mock-ups, and a Toyota dealer for
introduction to hybrid automobiles

Seminars

History of Transportation Engineering
Team Building Skills

Goals Met

The major goal of this program was to introduce middle school students from under-represented groups to basic scientific and engineering concepts. These groups have potential for science and engineering, but might lack role models and motivation to pursue a career in transportation engineering. The selection committee used the teacher references to rate the students (criteria were student statements of interest, teacher comments, and ethnicity). Through the UTCA summer program, we were successful in recruiting 85% female and 40% ethnic minority students for the program. The ethnicity breakdown is given in Table 4.1:

Table 4.1 Participant Ethnicity Information

Week 1	Percent	Female	Male
African American	35	2	5
Asian	5	1	0
Caucasian	50	10	0
Hispanic	10	1	1
Total number	100	14	6
Week 2			
African American	10	2	0
Asian	5	1	0
Caucasian	70	14	0
Hispanic	15	3	0
Total number	100	20	0

Significance and Benefits of the Program to Participants

The participants gained knowledge about the role of transportation planning, management, safety, and design in modern society. The emphasis was on how engineers use their knowledge in design applications. The last day of the Summer Institute concentrated on the team design in transportation engineering, where they combined the knowledge acquired in the laboratory experiences. A faculty member or professional acted as each team's mentor and helped them to prepare an electronic and oral presentation of their design. Students in the winning design team were awarded the K'nex kits and all participants received certificates of accomplishment from UAH at the closing ceremony. All the students received a prize of some kind, from the safety challenge, bridge design, solar car races, etc., which helped to instill a sense of accomplishment and pride.

Since the middle school curriculum contains hard science and algebra, which are directly related to engineering, this program enhanced classroom instruction with "hands on" experience. In addition, the principal investigators and professionals that acted as team mentors also functioned as role models for minority and female students. This may help to increase the numbers of these students that will go on to become transportation professionals. The use of UAH minority and women engineering students as lab assistants encouraged them to become involved in the community as professionals.

The program was intended to be a fun learning experience with a lot of basic information, team building skills, and hands-on laboratory experience of the latest transportation safety and

management technology. On the last afternoon of the program, the students were asked to complete a program survey course. Tables 4.2 and 4.3 show the results. The "favorite" experiments were the construction materials and alternative energy units. These will remain unchanged in the upcoming program. The least favorite, surveying, will be updated with more "fun" dynamic activities.

The students were also asked about their enjoyment of the program and unanimously responded in the affirmative regarding recommending this program to a friend (question 5), whether they would attend a similar program next year (question 6), whether the field trips and experiments increased their knowledge of engineering (question 7), and whether their knowledge has increased about activities of transportation engineers (question 8). The last question indicates their own views about engineering as a future career for them. Queried as to whether they might choose engineering as a profession, 35 of the 40 (87%) replied in the affirmative.

Table 4-2 Participants' Survey Results - Week 1 Participants

Survey Questions	Choice	
1. What was your favorite experiment?	Experiment 3 – Materials (20%), Experiments 5, 6, and 9 (15%)	
2. What was your least favorite experiment?	Experiment 4 – Surveying (40%)	
3. What was your favorite field trip?	Marshall Space Flt Center (40%)	
4. What was your least favorite field trip?	Old Railroad Museum (30%)	
	Yes	No
5. Would you recommend this program to a friend?	100%	0
6. Would you attend a similar program again?	100%	0
7. Do you feel like the field trips and experiments contributed to your learning experience?	100%	0
8. Did the program increase your knowledge of what transportation engineers do?	100%	0
9. Would you consider becoming an engineer?	90%	10%

In order to determine if this program has any long-term impact on participants, the alumni will be tracked on a yearly basis for mathematics and science involvement in high school. We also have plans to analyze the number of GUTEP alumni who ultimately become engineering students after high school.

Table 4-3 Participants' Survey Results - Week 2 Participants

Survey Questions	Choice	
1. What was your favorite experiment?	All (50%), Experiment 5 – Alt Energy (35%)	
2. What was your least favorite experiment?	Experiment 4 – Surveying (15%)	
3. What was your favorite field trip?	Old Railroad Museum (50%)	
4. What was your least favorite field trip?	Bridge Construction (35%)	
	Yes	No
5. Would you recommend this program to a friend?	100%	0
6. Would you attend a similar program again?	100%	0
7. Do you feel like the field trips and experiments contributed to your learning experience?	100%	0
8. Did the program increase your knowledge of what transportation engineers do?	100%	0
9. Would you consider becoming an engineer?	85%	10% No 5% Maybe

Advantages for participants

- fun and enjoyable exposure to science, engineering and transportation technology topics
- development of thinking and problem-solving skills
- participants learn what civil engineers do and their contributions to society
- meaningful and immediate experiential learning
- fuel for their natural curiosity
- self-directed learning opportunities in team design
- increased self-esteem from completion of institute
- multiple exposure to difficult topics and interrelationships to transportation issues
- opportunity to learn within academic facilities – may take away fear of technology
- diversity of mentors help students feel comfortable at institute

Student Involvement

The project employed four undergraduate student assistants (both minorities and females) to help in designing the projects, documenting plans, laboratory set-ups, and assist with the participating middle-school students at the Institute. Other university students acted as laboratory volunteers through the SWE, ASCE and NSBE student chapters.

Section 5

Project Conclusions

Education and Technology Transfer Activities

The team members completed the lab activities' manual (both teacher instruction and student activity guides) for implementation at school visits and for next year's program. A web page was posted through the UAH and UTCA home pages to allow on-line access.

Research Relevance and Impacts to Alabama

This project addressed the mission and several of the major goals of the UTCA. In addition, it provided educational experiences for under-represented groups of students within Alabama, and thus addressed diversity issues. This program has the potential to affect the future workplace (human resources issues). The students may wish to become involved in working on transportation-related safety research at an early age, which will help them gravitate toward the profession as they mature. The project also addressed the technology transfer goal of UTCA, since student assistants, mentors, and participants were exposed to state-of-the-practice-technology within the university curriculum.

The course end survey indicated that all students thought that the program was fun and educational. Most of them did not know what transportation engineers did prior to coming to UAH and were surprised at all the variations. They replied that they would all recommend the program to their friends.

Recommendations for Next Year's Program

The survey results will be helpful in composing next years' summer program. The two least favorite labs will be updated with new material and an additional lab will be added. A comment from the UAH student mentors was that the student participants would like more free time (outside of the classroom) to interact. Thus, a 10-minute afternoon "recess" with snacks will be added to the 2002 program.

Section 6.0 References

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APPENDIX A
Sample of Program Schedule

“GEARING UP FOR TRANSPORTATION ENGINEERING SUMMER INSTITUTE”
SUMMER 2001

Field Trips

Past Modes of Transportation

North Alabama Railroad Museum - Chase, AL

Current Modes of Transportation

Huntsville Jet port and Inter-modal facility

Transportation Engineering - City of Huntsville Engineering and Sign Shop

AL DOT Construction site - Highway 72

Future Modes of Transportation

NASA space station mock-ups (Space & Rocket Center Tour)

Hybrid battery powered car - Penney Toyota

Hands-On Sessions (4 Groups of 5 students each)

Title (coordinator)	Room
1. Strength of Materials -(JG)	TH N278
2. Space transportation - (SWE: Mary Anne, Yvonne)	TH S208 & 206
3. Construction Materials - (HT)	TH S228 & 230
4. Surveying - (Mike A & Dahlia)	Outside
5. Alternative Energy/Solar Cars - (KL)	TH S201
6. Bridges - (Norb)	TH S208
7. Transportation Simulation - (Mike A)	TH S239
8. Safety Concerns - (Lynn Dean)	TH S205
9. Designing the Car of the Future	TH S105

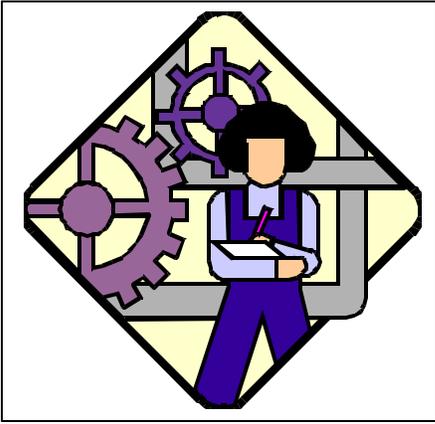
Table A.1: General Schedule of Sessions

	Monday 11th	Tuesday 12th	Wednesday 13th	Thursday 14th	Friday 15th
9-10	Introduction- History	Jetport - multi modal	RR museum	Future trans. MSFC - NASA tour	Team Design Project
10-11	Team building	Alternative energy car	City of HSV Engineering		
11-12	<i>Lunch – Pizza</i>	<i>Lunch - Hamburgers</i>	<i>Lunch - Picnic</i>	<i>Lunch - UC</i>	<i>Lunch -</i>
12 -1:45	Exp 1,2,3,4	Exp 1, 2, 3, 4	Exp 5,6,7,8	Exp 5,6,7,8	Exp 9. Dsn Competition
1:45- 2:00	Break	Break	break	break	
2:00-3:45	Exp 1,2,3,4	Exp 1, 2, 3, 4	Exp 5,6,7,8	5,6,7,8	Awards
4	Depart	Depart	Depart	Depart	Depart

Table A.2: Team Locations

	Mon 12 pm	Mon. 2 pm	Tues. 12 pm	Tues. 2 pm	Wed 12 pm	Wed. 2 pm	Thurs. 12 pm	Thurs. 2 pm
GROUP A	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8
GROUP B	Exp 2	Exp 3	Exp 4	Exp 1	Exp 6	Exp 7	Exp 8	Exp 5
GROUP C	Exp 3	Exp 4	Exp 1	Exp 2	Exp 7	Exp 8	Exp 5	Exp 6
GROUP D	Exp 4	Exp 1	Exp 2	Exp 3	Exp 8	Exp 5	Exp 6	Exp 7

APPENDIX B
Copies of New Experiments One, Seven, and Eight



Science Standards

Physical Science

- Motions and Forces

Science as Inquiry

Unifying Concepts and Processes

Process Skills

Observing

Collecting Data

Communicating

Inferring

Testing

Interpreting Data

1.

Mechanics of Materials

Objective:

To understand how forces and moments create stresses and strains in materials and structures.

Description:

Students will perform simple experiments in the UAH Mechanics of Materials Laboratory to demonstrate how forces and moments are created, and balanced to achieve equilibrium.

They will visualize how these quantities act to produce stresses in materials using the method of photoelasticity.

Metal samples will be tested to failure in torsion and tension to demonstrate the consequence of overloading a structure. Group members will take digital photographs to document their work.

Materials and Tools

Bathroom Scale and Balance Beam
Polariscope and Photoelastic Specimens
Torsion/Tension Fixtures and Specimens
Digital Camera and Computer System
Eye Protection and Safety Equipment

Background:

Forces and moments create stresses and strains in materials and structures. Stiffness, strength, and geometry are

important components in engineering design. A force represents the action of one body on another. It may be exerted by actual contact or at a distance, as in the case of gravitational and magnetic forces. A moment is created when a force tends to rotate a body about a point or an axis.

Forces and moments must be balanced to achieve equilibrium; *i.e.*, for a body to remain at rest or move with a constant velocity.

Stress is a measure of the force intensity in a material or structure while strain represents the shape changes that occur as forces and moments are applied.

Instructions

1a. Force & Moment Considerations

1. Weigh each group member and record this data on the report sheet.
2. Set up balance beam with the fulcrum at the center.
3. Have two group members stand on opposite ends of the beam at equal distances from the center. What happens? Why?
4. Adjust the positions of the team members until equilibrium is achieved. Measure the distance from the center of the beam to one group member and multiply by his/her weight. Do this for the other group member. What can you conclude?
5. Assume that one member will stand at a fixed distance from the center of the beam and that another member will stand in a position to achieve equilibrium. Record the weight and position of the first group member on the report sheet. Record the weight of the second member and compute the position required to achieve equilibrium. Test this configuration and list factors that may lead to errors on the report sheet.
6. Photograph two team members standing on opposite ends of the balanced beam while it is in equilibrium.

1b. Photoelasticity Experiments

1. Place a specimen with a hole in the center into a polariscope.
2. Apply a tensile load and observe how fringes form in different portions of the specimen.
3. Assuming that the number of fringes represents the stress level, what does the hole do?
4. Observe the fringes in different hand-held specimens to confirm this observation. Discuss how changes in

geometry affect stress on the report sheet.

5. Photograph group members while they are looking at the photoelastic specimens.

1c. Torsion Test

1. Obtain a metal specimen from the instructor.
2. Record the type of material on the report sheet.
3. Draw a straight line down the length of your sample.
4. Have the instructor help put the sample into the torsion fixture.
5. Have one group member turn the wheel and count the number of revolutions (watch the wheel).
6. Have another group member take a photograph of the others while they are doing the test.
7. Continue loading until your sample breaks.
8. Record the number of revolutions and the maximum torque on the report sheet.
9. Discuss and compare the results obtained for two different materials.

1d. Tension Test

1. Obtain a metal sample from the instructor.
2. Record the type of material and cross sectional area on the report sheet.
3. Have the instructor put the sample into the tension test machine.
4. Take a photograph of the experimental set-up.
5. Load the sample until it breaks.
6. Obtain a computer printout and discuss the results.
7. Record the maximum stress on the report sheet.
8. Look at the fracture surface and record what you see on the report sheet.

1e. Documentation

1. Download the camera using the computer.
2. Compile a photo album and print it out for distribution.

Discussion

1. What is a force?
2. How does a force create a moment?
3. How can the moment created by a given force be increased?

More Information

Additional information can be found in college textbooks on physics, statics, and mechanics of materials. Physics is usually taken in the freshman year. Statics and mechanics of materials are usually taught at the sophomore and junior levels, respectively.

1. Mechanics of Materials: Report Sheet

Group Name: _____

Make all measurements. Write your data in the spaces below.

1a. Force and Moment Considerations:

Weight of Member No. 1: _____ lb Weight of Member No. 2: _____ lb

Weight of Member No. 3: _____ lb Weight of Member No. 4: _____ lb

Weight of Member No. 5: _____ lb Weight of Member No. 6: _____ lb

Weight of 1st Group Member: _____ lb Position of 1st Group Member: _____ ft

Weight of 2nd Group Member: _____ lb

Calculations for Position of 2nd Group Member:

Answer: _____ ft

1b. Photoelasticity Experiments:

How do changes in geometry affect the stress distribution in a specimen?

1c. Torsion Test:

Type of Material: _____

Number of Revolutions to Failure: _____ Maximum Torque: _____ in-lb

Type of Material: _____

Number of Revolutions to Failure: _____ Maximum Torque: _____ in-lb

1e. Tension Test:

Type of Material: _____

Cross Sectional Area: _____ in² Maximum Stress: _____ Msi

Science Standards

Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Unifying Concepts and Processes

- Evidence, models, and explanation

Science and Technology

- Abilities of technological design

Science in Personal and Social Perspectives

- Science and technology in society

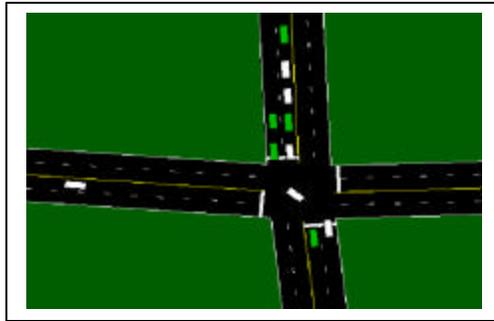
Science Process Skills

Collecting Data

Constructing

Inferring

7. Traffic Simulation



Objective:

To learn about the traffic engineering concept, level-of-service, and how traffic engineers use micro-simulation to analyze roadway intersections and design city streets.

Description:

In this activity, students explore traffic micro-simulation and determine existing and future levels of service for different roadway systems. The students will learn about highway design principles related to intersections and traffic signal control.

Materials and Tools

Computers

Micro-simulation software

Notebook

allowing travelers to change direction, if desired. The art of designing a functional intersection has been the focus of many studies and many software tools have been developed for this purpose.

Background:

From the earliest beginnings of the automobile, it has been necessary for travelers to change from one road to another. To accommodate this movement of vehicles, intersections were developed at road crossings

The topics covered are basic traffic engineering, intersection design, and why intersections have the lanes and configurations they do. Students become familiar with terms such as traffic level-of-service and micro-simulation analysis.

Instructions

1. The instructor will demonstrate a traffic simulation model and discuss the level-of-service concept.
2. You will then use the software and data provided to perform an analysis of an existing intersection.
3. You will then forecast future traffic flow for the intersection and will need to adjust lanes, add/remove turning lanes, and make signal timing changes to obtain the best possible level-of-service (or minimize the delay to the greatest extent) while limiting the cost of your design.

7. Traffic Simulation Report Sheet

Group Name: _____

1. Test an existing intersection to determine its level-of-service.
2. Test the same intersection with forecasted traffic conditions to see changes in level-of-service for the intersection.
3. Test different intersection configurations to obtain the best future level-of-service possible for the intersection.

Test #1: *Existing Level-of-service*

Make notes about the experiments here

<p>What is the existing level-of-service?</p> <p>_____</p> <p>What is the total traffic volume?</p> <p>_____</p>	
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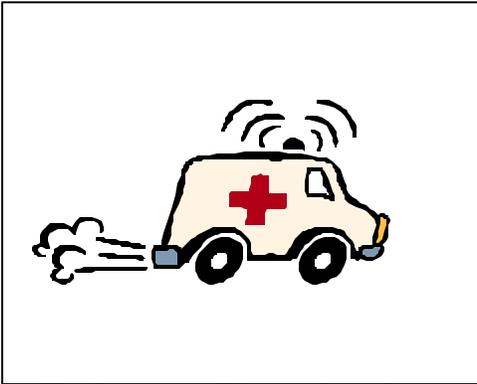
Test #2: *Forecast Traffic Conditions* Make notes about the experiments here

What is the forecast level-of-service? _____	
What is the total traffic volume? _____	

Test #3: *Alternative Configurations* Make notes about the experiments here

What is the change associated with adding a left turn lane? _____	
What is the change associated with adding additional lanes? _____	
What is the best level-of-service and delay value that you can develop? _____	
Using the formulas provided in class, what is the cost for the best design alternative? _____	

Test #4: *Draw your final design in the space provided.*



8. Transportation Safety

Science Standards

Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry
- Physical science
- Motions and forces

Science Process Skills

Measuring

Collecting Data

Interpreting Data

Controlling Variables

- Investigating safety issues

Objective:

To explore issues related to automobile safety. Also learn ways to design safety into cars.

Description:

In this activity, students learn about bike, bus and auto restraints safety. They also perform experiments illustrating safety features using eggs.

Materials and Tools

"Safety Challenge sheet"

Raw eggs (4-6)

Box with various materials: newspaper, tapes, marshmallows, paper towels, styrofoam cups, rubber bands, packing peanuts, bubble paper, garbage bags, string, straws

Notebook

Yard stick

Plastic sheet for ground cover

and other related areas. Airline safety can also be included in this topic. Although airlines have a better safety record than automobiles, airports are becoming more congested each year.

Moving objects have momentum. Newton's First Law states that unless an outside force acts on an object, the object will continue to move at its present speed.

The sad fact is that thousands of people still die annually in traffic crashes. When a vehicle is involved in a crash, passengers are still traveling at the vehicle's original speed at the moment of impact. When the vehicle finally comes to a complete stop, unbelted passengers slam into the steering wheel, windshield or other part of the vehicle's interior.

Background: Safety

Transportation safety includes bike safety, pedestrian safety, car safety and passenger (auto, air, and train) safety

Seat belts are your best protection in a crash. They are designed so that the forces in a crash are absorbed by the strongest area of your body -- the bones of your hips, shoulders and chest. They keep you in place so that your head, face and chest are less likely to strike the windshield, dashboard, other vehicle interiors, or other passengers. They also keep you from being thrown out of a vehicle.

(In Alabama alone, approximately 1150 people were killed last year.)

Did you know that airbags save over 1,500 lives per year? Amazing isn't it. For adults, airbags can seriously reduce the chance of injury in a crash-that's a good thing. What's not so good is that the force of an airbag when it's deployed can severely injure small children.

An air bag is made of coated fabric and is stored in a module mounted on the steering wheel. Crash sensors, which activate upon impact at speeds of 10-15 miles per hour, are mounted in several locations on the car chassis.

In a crash, the sensors ignite a chemical, sodium azide, which releases harmless nitrogen gas to instantly inflate the bag. As the driver or passenger is thrown into the bag, it applies a restraining force. Even though this entire process happens in only 1/25th of a second, the added time is enough to slow momentum to prevent serious injury.

Drinking and driving don't mix.
Drinking and driving don't mix.
Drinking and driving don't mix.

No matter how many times you've heard it, there are people who just don't get it. In fact, every 30 minutes, someone in this country dies in an alcohol-related crash. Every 30 minutes! And last year alone over one million people were injured in alcohol-related traffic crashes.

Instructions

8a. Safety Challenge

1. Answer questions on worksheet about bicycle, bus, and automobile safety.

8b. Automobile Safety

Purpose: Design ways to cushion an egg that is dropped through the air. Using the theories behind air bags in automobiles, find the best way to protect it from impact so you can drop it further.

1. Using the box of materials, you have 30 minutes to design and construct a safety compartment for your egg.
2. Place a raw egg into the compartment you designed.
3. Find the mass of each compartment and record it on the data sheet (note: lighter weights give higher final point values).
4. Drop each compartment, one at a time, and record if it survives a 3-foot fall.
5. For those eggs that survive, the egg compartment will be dropped 6 feet.
6. The surviving egg compartments will be dropped 9 feet.
7. Record your data on the worksheet and compute your final score.

Discussion

Air bags:

- ◆ *What happens to the egg's momentum?*
- ◆ *What would happen if you were dropping the egg directly on a concrete floor?*
- ◆ *What are some of the theories that can be used to transfer the momentum of the egg?*
- ◆ *Would a parachute attached to the egg provide enough cushion to keep it from breaking? How high could you drop an egg attached to a parachute?*
- ◆ *Is it possible to design a springing car to absorb the impact of accidents by itself?*
- ◆ *Does the height of the drop make a big difference? Remember: force = mass times acceleration.*

Additional Information:

"Web sites" for more information:

<http://www.nhtsa.dot.gov/kids/research/airbag/index.html>

www.wsdot.wa.gov/regions/northwest/Noise/8.html

www.fhwa.dot.gov/environment/probresp.htm

www.guilite.com/highway.html

8c. Safety Report Sheet

Group Name: _____

4. Mass of your safety compartment with egg inside _____ gr.

5. .

Student's name		Points	Total
Drop 3 feet	Survive? Yes = 300 pts No = 0 pts		
Drop 6 feet	Survive? Yes = 600 pts No = 0 pts		
Drop 9 feet	Survive? Yes = 900 pts No = 0 pts		
Final Points = total points / mass			

APPENDIX C
Photos from GUTEP 2001



Figure C1: On-line Bridge Design



Figure C2: Construction of Bridge



Figure C3:. Alternate Energy Experiment: Solar-powered Auto



Figure C4: Transportation of the Future Presentation



Figure C5: GUTEP Participants - Girl Scout Week